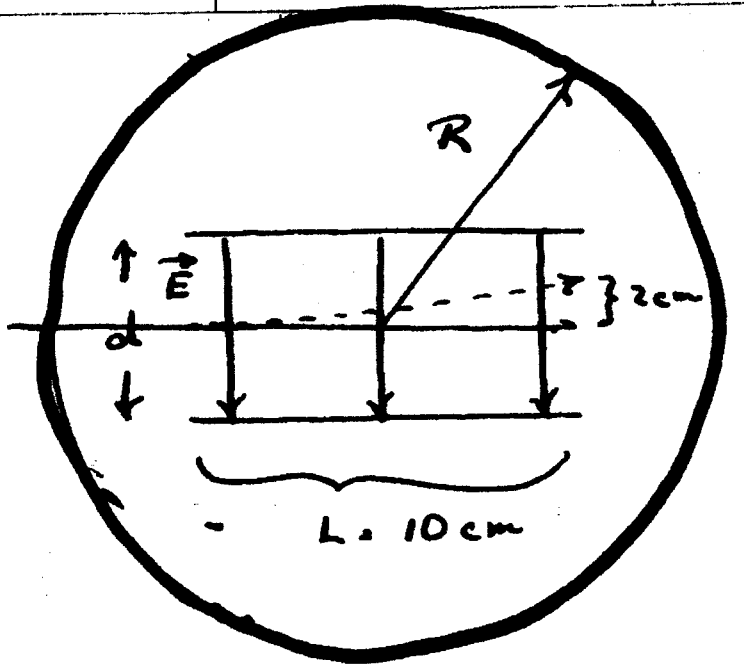


LECTURE DEMONSTRATION

PLATES $V = 2.5\,kV$

$A = 9cm \times 35cm$

$d = 5cm$

COIL $I = 232mA$

$N = 320$

$R = 6cm$

DEFLECTION ($\vec{E} \perp \vec{B}$) $y = 2cm$

1) ELECTRON BEAM = $4.8\,keV$

$$KE = \frac{1}{2} m v^2 = qV = 1.6\times10^{-19}C \cdot 4.8\times10^{3}V$$

$$v = \left(\frac{2 \cdot 1.6\times10^{-19}C \cdot 4.8\times10^{3}V}{9.1\times10^{-31}kg} \right)^{1/2}$$

$v = 4.13\times10^{7}\,m\,s^{-1}$ but e⁻ will lose energy in transit so we can't use this

2) CAPACITANCE OF PLATES

$$C = \frac{\varepsilon_0 A}{d}$$

$$= 8.85\times10^{-12} \times \frac{.09\times.035}{.05}$$

$$= 5.6\times10^{-13}\,F$$

3) ELECTRIC FIELD

$$E = Vd^{-1}$$

$$= 2.5kV / .05m$$

$$= 5\times10^{4}\,V\,m^{-1}$$

4) MAGNETIC FIELD

$\vec{B}$ due to loop

$$B = \frac{\mu_0 I}{2R} \quad \text{for single turn}$$

$$B = \mu_0 \frac{NI}{2R} \quad \text{for } N \text{ Turns}$$

$$= 4\pi\, 10^{-7} \times \frac{320 \times 0.232\ A}{2 \times .06\ m}$$

$$= 7.77 \times 10^{-4}\ T$$

5) VELOCITY

For no deflection

$$F_E = qE = F_B = qv \times B$$

$$v = \frac{E}{B}$$

$$v = \frac{5 \times 10^4\ V\,m^{-1}}{7.77 \times 10^{-4}\ T} = 6.6 \times 10^7\ m\,s^{-1}$$

6) CHARGE TO MASS

In E field get deflection:

$$y = \frac{1}{2} a t^2 = \frac{1}{2} \frac{F}{m} t^2 = \frac{1}{2} \frac{qE}{m} t^2$$

$$t = \frac{L}{v} = \frac{LB}{E}$$

$$y = \frac{1}{2} \frac{q}{M} E \left(\frac{LB}{E}\right)^2 = \frac{1}{2} \frac{q}{m} \frac{L^2 B^2}{E}$$

or

$$\frac{q}{m} = \frac{2yE}{L^2 B^2} = 3.3 \times 10^{11} \quad \left(\frac{1.6 \times 10^{-19}}{9.1 \times 10^{-31}} = 1.76 \times 10^{11}\right)$$

7) We have used idealized eqns E B in particular are not quite uniform (edge effects)

Ability to measure q/m lead to discovery of isotopes

Nucleus p^+ n ^4He

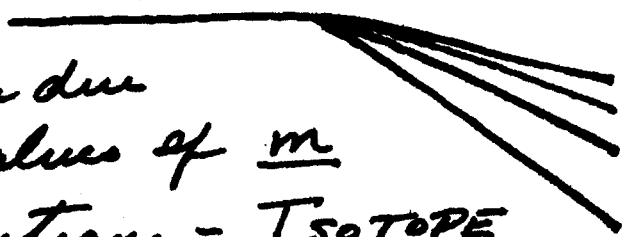
# of protons determines which element. Nucleus also contains neutral particles "neutrons"

typically $\#_n \sim \#_p$

Nucleus held together by nuclear forces.

Nucleus surrounded by cloud of electrons e^-. If $\#e^- = \#p^+$ atom is electrically neutral. Remove electron atom is positively charged - Ion

When looked at positive ions in Thomson expt found that ions of certain elements showed multiple deflections. Same due to diff't values of charge



Others must be due to different values of m

$\Rightarrow$ # of neutrons - ISOTOPE

$^{20}Ne \Rightarrow 10p^+ \; 10n$ $\quad$ $^{22}Ne \Rightarrow 10p^+ \; 12n$